



# PSYCHE.

ORGAN OF THE CAMBRIDGE ENTOMOLOGICAL CLUB

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## The Anatomy of *Amblychila cylindriformis* Say.

(With lithographic plate 1.)

### LITERATURE.

*Imago.* Schaupp: On the Cicindelidae of the United States (Bull. Brooklyn Entom. Soc., June 1878, v. 1, no. 2, p. 5).

*Larva.* Horn: Descriptions of the larvae of the North American genera of Cicindelidae, . . . (Trans. Amer. Entom. Soc., 1878, v. 7, p. 28-40, pl. 2.)

See also Brous: Habits of *Amblychila cylindriformis* (Trans. Kansas Acad. Sci., 1877, v. 5, p. 11-12), and Snow: *Amblychila cylindriformis* Say (Trans. Kans. Acad. Sci., 1878, v. 6, p. 29-32).

I began the investigations recorded in the present paper in the winter of 1877-8, on the receipt of fifty specimens of *A. cylindriformis* from Mr. George Porter Cooper, of Topeka, Kansas, but dropped the subject in the spring, and only took it up again in January 1879, on the receipt of fresh material from Prof. F. H. Snow, of the State University, Lawrence, Kansas. I had occasion also to dissect numerous specimens of *Omus audouinii*, received from northern California and from Prof. O. B. Johnson, Salem University, Oregon.

In comparing the two genera, I find that they differ in several points. *Omus* has the facets of the cornea of the eye convex,<sup>1</sup> while in *Amblychila* the eye is entirely smooth. The accessory

<sup>1</sup> *Omus* and many other Cicindelidae have not only very convex facets on the cornea but also comparatively large eyes, both these characters giving more distant sight than *Amblychila* has. The cones are biconvex in *Omus*, while in *Amblychila* they are only convex interiorly. The more anterior position of the eye in many Cicindelidae gives better sight than a lateral position would give; in the latter case the antennae are of far more use, as organs of touch, than in the former.

gland of the male sexual organ of *Amblychila* (Fig. 9 *b*)<sup>1</sup> is more dilated than in *Omus* and the bending of the testis is in the reverse direction; there is also in *Omus* a double pair of long accessory tubes discharging their contents into the vas deferens, each pair of these tubes uniting near their insertion. The tip of the penis is acute in *Amblychila* (Fig. 13 *A*) but is rounded in *Omus* (Fig. 13 *B*). The last abdominal segment is emarginate in all the genera of our fauna except *Amblychila*. I do not know whether this emargination corresponds with the form or position of the tip of the penis, or not, but it is certain that most, if not all, the species of the different genera fly around *in copula*, and the emargination may help to make this possible.

In looking over the family of Cicindelidae in a speculative way, I drew the inference that the line of descent diverged (probably in the mesozoic age) into branches, the lowest<sup>2</sup> and certainly the oldest of which is still represented in the genus *Amblychila*. In *Omus*, *Tetracha*, *Cicindela pilatei*, *C. maga*, *C. cursitans* and *C. celeripes* we have an aberrant lesser branch, the latter genera being closely linked with the rest of the Cicindelidae.

Contemplating the law of adaptation and heredity, I arrived at the conclusion that the prototype of *Amblychila* formerly lived on the shores of the great intercontinental gulf in cretaceous times, before the arrival of *Cicindela hirticollis* and *C. lepida*,<sup>3</sup> and was in those ages provided with a more specialized structure, which by degrees became retrograded and inherited, when its survivors adapted themselves to the clay-banks of the undulating prairies of Colorado and Kansas. It probably formerly led a life, like its congeners in Mexico and South America, on leaves of trees, along the shores of the great gulf; the consequent breaking up of the latter into innumer-

<sup>1</sup> The figures referred to are on Plate 1.

<sup>2</sup> Deficient in organ of sight, less specialized in organs of reproduction and in larva, reduced in abdominal segments and wanting wings.

<sup>3</sup> LeConte: Address of Retiring President (Proc. Amer. Ass. Adv. Sci., 1875 [v. 24], p. 1-18), p. 4. Horn: Notes on some coleopterous remains from the bone cave at Port Kennedy, Penna. (Trans. Amer. Entom. Soc., 1876, v. 5, p. 241-245) (Misc. papers on Amer. coleoptera, p. 241-245), p. 241.

able salt and brackish lakes being the primary cause of its retrogradation.<sup>1</sup>

Owing to the light membranous body of insects, they were less likely to be destroyed<sup>2</sup> in pre-historic evolutions than were vertebrates and many invertebrates; consequently future researches in the rich deposits of the Rocky Mountain tertiaries may yet reveal the fossil ancestor of Amblychila.

As a secondary adaptation, I mention the pubescence of the middle tibia in the male of Megacephalini and Cicindela (excepting in *C. pilatei* and *C. maga*, where it is glabrous). It is intended for a firmer hold of the female during copulation; in Amblychila the dilation of the anterior tarsi in the male was dropped as useless, probably owing to the smooth cylindrical thorax of the female, and was replaced by an acute hind trochanter<sup>3</sup> for firmer insertion into the funnel-shaped pores between the ridges of the elytra of the female. This structure was useless to the female and therefore the trochanter remained blunt. We find similar inherited adaptations in the serrulate and curved middle tibia of *Calosoma sayi*;<sup>4</sup> the dilation of the anterior tarsi was in this instance preserved. Although *C. sayi* occurs frequently in Kansas and thereabouts, its frequency is probably checked by some enemy; its large size, and perhaps other causes, lessen its number. The interrupted elevations between the longitudinal ridges of its elytra are also, perhaps, fit for the acute trochanter of the male.

Whenever we find characters dropped because they are of no apparent use, we find them existing elsewhere, where they are probably also useless. They are merely — as are, for instance, the arthropodous trochanters — rudimentary organs which become important indications in comparative anatomy for tracing their ancestral connections, at the same time teach-

<sup>1</sup> LeConte: Classification of the coleoptera of North America, p. 1.

<sup>2</sup> LeConte: Address (*l. c.*), p. 8. "Cataclysms and submergences, which would annihilate the higher animals, would only float the temporarily asphyxiated insect, or the tree trunks containing the larvae and pupae to other neighboring lands."

<sup>3</sup> Horn: Sexual characters of North American Cicindelidae . . . (Trans. Amer. Entom. Soc., 1875, v. 5, p. 232-240, pl. 1 in part) (Misc. papers on Amer. coleoptera, p. 232-240, pl. 1 in part), pl. 1, fig. 18.

<sup>4</sup> Horn: *ibid.*, pl. 1, fig. 26.

ing, also, how an organ is apparently preserved without purpose for an indefinite time. In order to understand the teleology of certain inherited organizations it is necessary to be perfectly acquainted with the external conditions and the biology of the respective species. Adapted forms and accommodations are explicable only upon such conditions. Since the determining impulses for transitions and changes in organisms lie outside of the latter, or are to be sought there for the greater part, they thus often escape our observation.

Instances could also be mentioned of sexual peculiarities which seem to be in opposition to easy copulation, yet the species are abundant. Such apparently conflicting facts could undoubtedly be explained if we had full knowledge of the peculiar biology of those species. Amateur entomologists ought, therefore, by accurate biological observations, to concentrate their studies especially upon this generally neglected theme.

#### ANATOMY OF THE IMAGO.

*Integument.* The dark brown elytra exhibit, on the upper side, elevated longitudinal beads and funnel-shaped punctures. In a deeper layer, next to the hypodermis, are several longitudinally meandering cylindrical canals, running between the pores and the beads. The larger, serially arranged pores just reach the chitinogenous matrix (hypodermis), forming a minute protuberance, while the smaller, more or less irregularly placed pores, pierce the matrix. The circular fibrous area of each of the larger pores forming a third group has an interruption, which is always on the side towards the base of the elytra, and appears to be a concave groove, the exact nature of which I did not succeed in disclosing. (Fig. 7.)

On macerating a piece of the head alternately in caustic potash and acetic acid, three different sizes of pigment-granules can be discerned in the cuticula: first, a fine granulation, second, an irregularly arranged coarser granulation, and third, a nearly round, homogeneous assemblage of larger spots.

A broad zone of spinous excrescences, arranged like tiles, extends along the pleurae of the abdominal integument between and around the stigmata.

*Inner skeleton.* For the suspension of the pharynx two chitinous furcate processes are fastened to the roof of the anterior portion of the head. Each process has a hook above the pharynx and a membrane at its lower portion, which connects with the other process. (Fig. 12.) Another chitinous process extends longitudinally along the roof of the thorax, and serves for the insertion of muscles. Similar organs have been observed in many other insects, always serving either for the insertion of muscles or for the support of delicate organs.

*Alimentary canal.* (Fig. 4.) The most anterior muscular portion of the canal, the pharynx, first bends upward, passes through a chitinous diaphragm formed by the above-mentioned processes, and then reaches nearly down to the base of the head. At this point its lower part is contracted by a sort of sphincter pharyngis. The chitinous and membranous continuation, the oesophagus, gradually widens its lumen, and ends with a capacious bladder, the ingluvies, or crop.

The pharynx has two layers, the inner of which consists of quite large glandular cells, occasionally including small tracheal branches. The glandular cells are densely grouped in the transverse and longitudinal folds. The outer layer consists of a sheath of ring-muscles, which are, along the longitudinal glandular cell-folds, covered with a layer of longitudinal muscular fibres. The fibres of the longitudinal muscles are broader than those of the ring-muscles. In order to convey a better idea of the complicated arrangement of the two layers in the pharynx, Fig. 14 is added: *e* and *d* belong to the outer, *a*, *b*, *c* and *f* to the inner layer.

The structure of the membrane of the oesophagus and ingluvies is perfectly homogeneous, the latter taking charge of the maceration of the semi-fluid nourishment and the expulsion of undigested food. The contents of the ingluvies are in all cases a dirty grey emulsion, mixed with a fine, crystalline, sand-like sediment. As *Amblychila* lives in clay-holes, probably it swallows, along with its food, a quantity of clay, for the purpose of comminuting and crushing its food, with the assistance of the triturating muscles of the proventriculus, as is the case in many other insects.



The widest lumen of the ingluvies is in the neighborhood of the first abdominal segment. A powerful muscular complex forms the proventriculus, and consists of eight flesh-colored fascicles, a little over 2 mm. long, convex outside and concave inside at the base. The broader bases of the fascicles are closely fitted to the proventriculus, and their pointed ends are turned backward. Two of these eight fascicles are connate, exhibiting a deep longitudinal fold at their connection. Each fascicle terminates in a chitinous tooth, and the entire complex is covered with tooth-shaped excrescences, or aciculi, directed backward and outward. The same apparatus exists in *Omus* and in many other insects.<sup>1</sup> In the larva of *Corethra*, a dipteran, these spines are directed toward the lumen of the pharyngeal bulb, forming a sort of weir-basket, and the mechanism as well as the function of this apparatus must be different from that of the complex in *Amblychila*.

Just behind the proventricular apparatus three pairs of Malpighian vessels discharge their contents into the very narrow and compactly muscular chylic ventricle. They are of considerable length, winding themselves through the lobes of the corpus adiposum, but are not in any way extraordinary, having the histological structure of Malpighian vessels in other insects.

Four other short, yellow sheaths, or utricular organs, also discharge into the chylic ventricle. Their envelope shows very fine, transverse lines, which do not, under high magnifying power, prove to be ring-muscles. The contents of these sheaths is an aggregation of closely packed, glandular lobules. I assume them to be functionally the so-called pyloric appendages. They neither precede nor follow the Malpighian vessels but are closely intermingled with the latter, and only with difficulty can be traced to their insertion.

The anterior portion of the chylic ventricle, connected with the Malpighian vessels and pyloric appendages, consists of a thickened external layer of fine fibrous network with large meshes, having from three to six yellowish glandular lobes enclosed in each mesh. (Fig. 8 *a* and *b*.) The anterior part of

<sup>1</sup> Burmeister: Handbook of entomology, translated by Shuckard. 1836.

the chylific ventricle, with its glandular envelope, is probably the true digesting portion, and the posterior part serves for the absorption of chylified fluid.

The course of the chylific ventricle is straight. Its length, in contracted alcoholic specimens, is about 25 mm. ; its diameter, 1.5 mm. Owing to its tough muscular substance, it is supposed to be capable of extension and contraction, and to have peristaltic motions, in the living animal.

The chylific ventricle terminates with a sort of sphincter, reaching into the third and last part of the alimentary system, the rectal bladder (Fig. 4 *g*).

The rectal bladder is of the same form as the ingluvies and, like the latter, is a capacious organ with thin, chitinous walls. Its widest lumen is toward the chylific ventricle, and it gradually narrows to within about 3 mm. from the anal orifice, to which extends a narrow muscular tube. Shortly before reaching this tube the rectal bladder is provided with glandular, longitudinal folds like those mentioned in the pharynx.

Six ellipsoidal bodies, rectal cells (Fig. 4 *h*), equidistant from each other, form a sort of girdle around the widest part of the bladder. Similar organs have been observed long since in other insects, and much has been written about them, to which I can add but little. Omus has them. Their physiological action has not been sufficiently explained, though, in general, they are regarded as excretory organs.

The rectal cells of *Amblychila* are 2 mm. long, and about 0.9 mm. wide (Fig. 5), and have a chitinous, lemon-colored wall, consisting of four layers (Fig. 6). The central part is filled by a simple cell-layer, consisting of an aggregation of large, colorless cells, closely packed and therefore appearing oval-polygonal. The outermost layer of the wall is the narrowest, and is colorless and structureless; the second is one-half broader, colorless and structureless; the third is as broad as the two outer together, yellow, convex outwardly and structureless; the innermost is as broad as the second outer, yellow, and exhibits under high power, glandular canals running toward the large central cells. The latter are plainly nucleated.

*Circulatory system.* There is, as in all insects, a contractile (pulsating) dorsal vessel, with venous ostia and arterial branches; but it was impossible for me, in the numerous specimens received in a dampish condition, to find the dorsal vessel or its ramifications, which would have been easily done in living individuals.

*Respiratory system.* Amblychila has seven pairs of stigmata (nine in the larva). The tracheae present a diversified system of ramifications, with the occasional occurrence of dispersed tracheal expansions, or bulbs, in the smaller branchlets, as is the case in other insects. Correspondences occur between the tracheal system and many of the other organs (corpus adiposum, integument and muscles), whereby an aeration of the blood is not only possible in all parts of the body but also in the respective tissues themselves.

The respiratory system assists locomotion by considerably lessening the specific gravity of the body.

*Muscular system.* But little can be said about the muscular system of Amblychila, though a few general remarks may be useful and instructive. As in all arthropoda the muscles are individualized, consisting of a number of single fascicles of fibres. The wings are wanting and the elytra connate, consequently the muscles destined for the wings are rudimentary. A number of leg-muscles are inserted on both sides of interior prothoracic processes. Stout fascicles in the head move the oral organs of this carnivorous insect. Several ligaments and membranes connect the head with the thorax, and the latter with the abdomen. The pharyngeal muscles have been mentioned before.

As is the case in all arthropoda the muscular fibres are transversely striate. Since I received only dead specimens, I could find only striate muscular fibres; striate fibres also occur in living insects, however, as Franz Leydig and August Weismann showed in the larva of Corethra.

*Nervous system.* (Fig. 1.) I succeeded in tracing the nervous system in several individuals. Having macerated the bodies in water several days, I opened them from above, at the sides, and having carefully removed corpus adiposum, digestive



## PLATE 1.

(*Drawn and engraved by C. F. Gissler.*)

### EXPLANATION OF FIGURES.

Fig. 1. Nervous system of *Amblychila*. Natural size.

*a*, antennal nerve [natural position is behind the optic nerve]; *b*, eye; *c*, supraoesophageal ganglion; *d*, infraoesophageal ganglion; *e*, first thoracic ganglion; *f*, second thoracic ganglion; *g* to *k*, first to fourth abdominal ganglia; *l*, terminal cords; *m*, fifth abdominal ganglion; *n*, ventral pair of nerve cords arising from the infraoesophageal ganglion.

Fig. 2. Optic nerve with swelling and ganglionic expansion. Enlarged.

Fig. 3. Vertical section through cornea and crystalline lenses; the latter are convex, interior prolongations of the cornea. Enlarged.

Fig. 4. Alimentary canal. Slightly enlarged.

*aa*, pharynx; *a*, oesophagus; *b*, ingluvies; *c*, proventricular triturating muscular apparatus; *d*, Malpighian vessels (shortened); *e*, accessory glands (shortened); *f*, chylific ventricle; *g*, rectal bladder; *h*, rectal cells.

Fig. 5. A rectal cell, moderately magnified.

Fig. 6. Wall of a rectal cell, highly magnified.

Fig. 7. Elytral pores.

*a*, small and plain pore of the elytron; *b*, large ring-pore of the elytron; *c*, large ring-pore interrupted by a concave groove.

Fig. 8. Anterior external coat of chylific ventricle.

*a*, fibrous network moderately magnified; *b*, one of the meshes highly magnified.

Fig. 9. Male sexual organs. Slightly enlarged.

*a*, testicle; *b*, vas deferens (the swollen part = vesica seminalis); *bb*, Ductus ejaculatorius; *c*, process of preputium; *cc*, base of penis; *cp*, preputium; *d*, penis; *e*, distending process; *ee*, corneous ridge of preputium.

Fig. 10. Chorion of egg. Magnified.

Fig. 11. Micropyle of chorion. Highly magnified.

Fig. 12. Chitinous process in head. Enlarged.

*a*, bifurcate insertion; *b*, process; *c*, membrane.

Fig. 13. Penis. Slightly enlarged.

A. of *Amblychila*; B. of *Omus*.

Fig. 14. Portion of pharynx. Moderately enlarged.

*a*, tracheal branch; *b*, longitudinal glandular fold; *c*, polygonal glandular cells; *d*, ring-muscles; *e*, longitudinal muscle-fibres; *f*, transverse glandular fold.





